Editorial

Advances in Lie Groups and Applications in Applied Sciences

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This special issue was planned to focus on most the recent advances in the applications of Lie groups. It covered a wide area of topics in interdisciplinary studies in mathematics, mechanics, physics, and finance. We were particularly interested in receiving novel contributions devoted to Lie groups, in particular, applications to specific problems in applied sciences. We aimed to bring together contributions across a variety of applications of Lie groups and invite researchers to submit original research and/or domain reviews in various topics. Potential topics included, but were not limited to the following: Lie algebras and Lie pseudogroups, optimal control, topological groups, representation theory of Lie algebras, differential geometry, finance, dynamical systems, quantum mechanics, super-symmetry and superintegrability, information theory, Lie theory and symmetry methods in differential, fractal differential, integrodifferential, and difference equations, and further applications in physics and mechanics.

From different areas of Lie groups and applications in applied sciences mentioned above, we have received papers, above thirty, from different countries for consideration in this special issue and eighteen papers have been accepted for this special issue. The brief descriptions for each of the accepted papers are given below.

In their study “Invariant operators of five-dimensional nonconjugate subalgebras of the Lie algebra of the Poincaré group $P(1,4)$ ” V. Fedorchuk and V. Fedorchuk classify all five dimensional nonconjugate subalgebras of the Lie algebra

of the Poincaré group $P(1,4)$ into classes of isomorphic subalgebras. In addition, they construct invariant operators of the questioned algebras.

In their study “Conservation laws of three-dimensional perfect plasticity equations under von Mises yield criterion” by S. I. Senashov and A. Yakhno, the authors seek conservation laws of (1) von Mises plasticity equations in three dimensions, (2) the plane stress equations, and (3) the plane strain equations. In the first case, the conservation laws are found via Lie point symmetries and the Noether’s theorem. For the other two systems, the approach of Vinogradov and Krasil’shchik is used. As a result, for the plane stress and the plane strain equations, linear homogeneous PDEs satisfied by conservation law fluxes are derived, and applications of the obtained conservation laws to complete solution of specific Cauchy problems are considered.

In the study “Algebraic structures based on a classifying space of a compact Lie group” D.-W. Lee studies the algebraic structures on the classifying space of a compact Lie group and by using the Milnor-Moore theorem; he also investigates the concrete primitive elements in the Pontrjagin algebra.

In their study “Post-Lie algebra structures on the Lie algebra $gl(2, \mathbb{C})$,” Y. Sheng and X. Tang give a complete classification of post-Lie algebra structures on the Lie algebra up to isomorphism.

In their study “Group analysis and new explicit solutions of simplified modified Kawahara equation with variable coefficients” G. W. Wang and T. Z. Xu study the simplified modified

Kawahara equation with variable coefficients by using Lie symmetry method. They also present Lie algebra, optimal system, the similarity reduction forms and some invariant solutions.

In their study “*The centroid of a Lie triple algebra*” X. Liu and L. Chen completely determine the centroid of the tensor product of a simple Lie algebra and polynomial ring.

In their study “*Infinite-dimensional modular Lie superalgebra Ω* ” X. Xu and B. Mu study ad-nilpotent elements of the infinite-dimensional Lie superalgebra over a field of positive characteristic and classify the infinite-dimensional modular Lie superalgebra.

In their study “*Reductions and new exact solutions of ZK, gardner KP, and modified KP equations via generalized double reduction theorem*” R. Naz et al. study Lie symmetries, conservation laws, reductions, and new exact solutions of Zakharov-Kuznetsov (ZK), Gardner Kadomtsev-Petviashvili (GKP), and Modified Kadomtsev-Petviashvili (MKP) equations.

In their study “*The automorphism group of the Lie ring of real skew-symmetric matrices*” J. Xu, B. Zheng, and L. Yang study and characterize the automorphism group of the Lie ring.

In their study “*The natural filtration of finite dimensional modular Lie superalgebras of special type*” K. Zheng and Y. Zhang investigate the natural filtration of Lie superalgebra $S(n; m)$ of special type over a field of prime characteristic. They first construct the modular Lie superalgebra $S(n; m)$ and then they prove that the natural filtration of $S(n; m)$ is invariant under its automorphisms.

In the study “*A kind of infinite-dimensional Novikov algebras and its realizations*” L. Chen constructs a kind of infinite-dimensional Novikov algebras and presents its realization by hyperbolic sine functions and hyperbolic cosine functions.

In the study “*A realization of Hom-Lie algebras by Iso-deformed commutator bracket*” X. Li constructs classical Iso-Lie and Iso-Hom-Lie algebras in by twisted commutator bracket through Iso-deformation and gives their Iso-automorphisms and isotopies.

In their study “*First integrals, integrating factors, and invariant solutions of the path equation based on Noether and λ -Symmetries*” G. Gün and T. Özer investigate the lambda-symmetry properties, classification and the corresponding reduction forms, and integrating factors of the path equation. In addition, they apply the Jacobi last multiplier method as a different approach to determine the new forms of lambda-symmetries.

In their study “*On the homomorphisms of the Lie groups $SU(2)$ and S^3* ” F. Özdemir and H. Özekes construct all the homomorphisms from the Heisenberg group to the 3-sphere. By defining a topology on these homomorphisms, they regard the set of these homomorphisms as a topological space. Next, using the kernels of homomorphisms, they define an equivalence relation on this topological space and they show that the quotient space is a topological group which is isomorphic to S^1 .

In their study “*A variational approach to an inhomogeneous second-order ordinary differential system*” B. Muatjetjeja

and C. M. Khalique study the coupled inhomogeneous Lane-Emden system from the Lagrangian formulation. They classify the system with respect to a first-order Lagrangian according to the Noether point symmetries and then obtain first integrals of the various cases.

In their study “*Exact solutions and conservation laws of a $(2 + 1)$ -dimensional nonlinear KP-BBM equation*” K. R. Adem and C. M. Khalique investigate the two-dimensional nonlinear Kadomtsev-Petviashvili-Benjamin-Bona-Mahony equation. They obtain exact solutions and the conservation laws.

In their study “*Lie group analysis and similarity solutions for mixed convection boundary layers in the stagnation-point flow toward a stretching vertical sheet*” S. S. Chaharborj et al. study the mixed convection boundary layers in the stagnation-point flow toward a stretching vertical sheet via symmetry analysis.

In their study “*Algebraic properties of first integrals for scalar linear third-order ODEs of maximal symmetry*” K. S. Mahomed and E. Momoniat analyze the relationship between the first integrals of the simplest linear third-order ODEs and their point symmetries. They show that the maximal Lie algebra of a first integral for the simplest equation $y''' = 0$ is unique and four-dimensional.

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